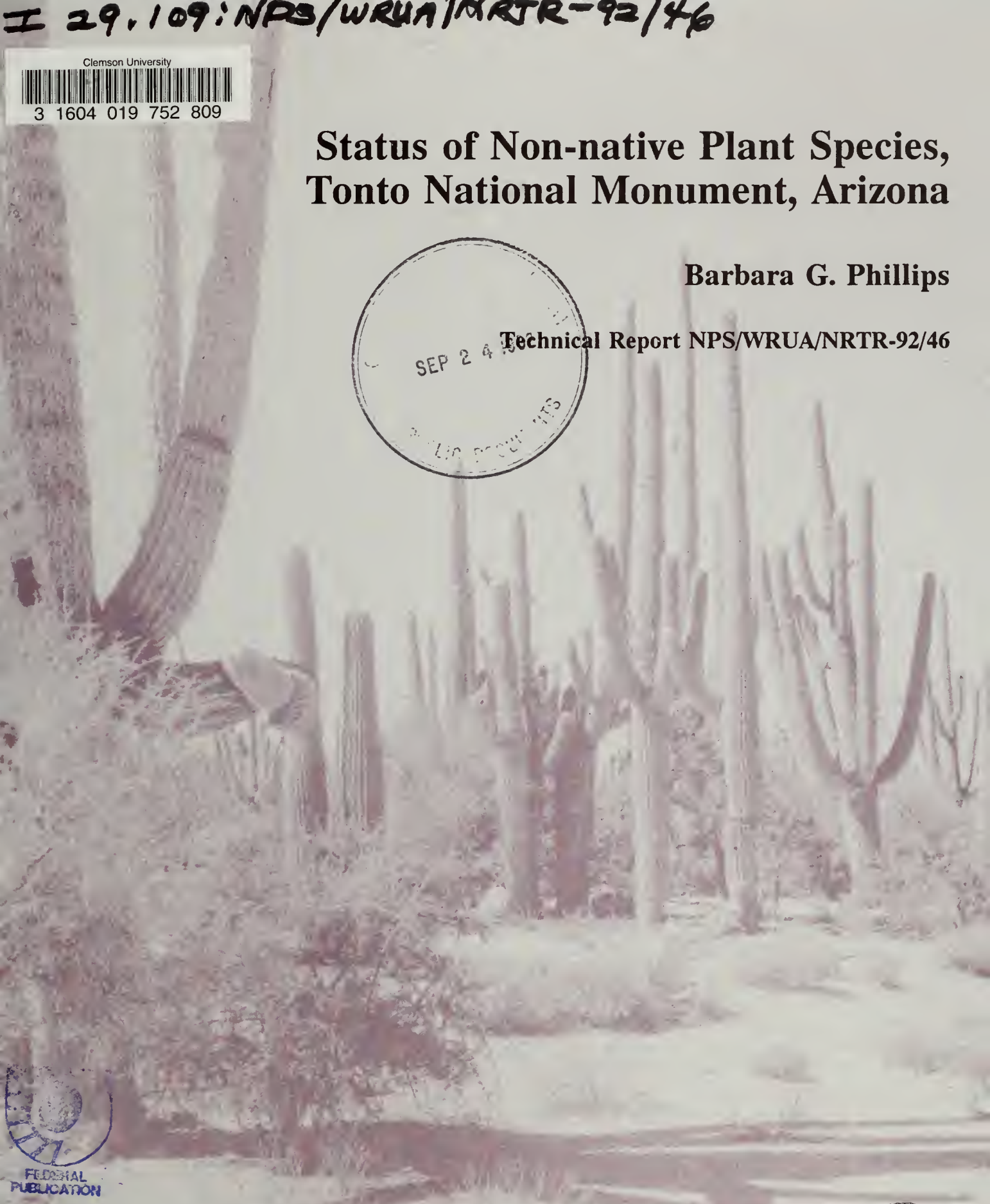
Status of Non-native Plant Species, Tonto National Monument, Arizona

Barbara G. Phillips

Technical Report NPS/WRUA/NRTR-92/46



United States Department of the Interior
National Park Service ♦ Western Region
Cooperative National Park Resources Studies Unit
The University of Arizona ♦ Tucson, Arizona

COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT

The University of Arizona, Tucson

The Cooperative National Park Resources Studies Unit/University of Arizona (CPSU/UA) was established August 16, 1973. It is one of five such units in the Western Region (Arizona, California, Hawaii, and Nevada) of the National Park Service (NPS). Principal Arizona cooperators include the School of Renewable Natural Resources in the College of Agriculture and the Department of Ecology and Evolutionary Biology of The University of Arizona. The Western Archeological and Conservation Center (NPS) and the School of Renewable Natural Resources (UA) provide administrative assistance. Unit scientists hold courtesy faculty or research associate appointments at the university.

The CPSU/UA provides a multidisciplinary approach to studies in natural and cultural sciences. Funded projects given high priority by park managers are investigated by NPS and university researchers under coordination of the CPSU. Unit staff also cooperate with researchers involved in projects funded by non-NPS sources to obtain information needed by park managers.

The Technical Report series allows dissemination of reports about high priority resource management needs. The series allows the flexibility of retaining considerable information on study design, methods, results and applications not afforded in formal scientific publications. Technical reports are given peer review and editing; guidelines for report preparation are being developed. Documents in this series usually contain information of a preliminary nature and are prepared primarily for use by NPS personnel and cooperators. Mention of trade names or commercial products does not constitute endorsement and/or use by NPS.

THE UNIVERSITY OF
ARIZONA
TUCSON ARIZONA

Status of Non-native Plant Species, Tonto National Monument, Arizona

Barbara G. Phillips

Technical Report NPS/WRUA/NRTR-92/46

August 1992

National Park Service
Cooperative National Park Resources Studies Unit
School of Renewable Natural Resources
125 Biological Sciences East
The University of Arizona
Tucson, Arizona 85721

AUTHOR

Barbara G. Phillips[1], Consulting Botanist
Px 8601-7-0110

UNIT PERSONNEL

William L. Halvorson, Unit Leader
Peter S. Bennett, Research Ecologist
Michael R. Kunzmann, Ecologist
Katherine L. Hiett, Biological Technician
Joan M. Ford, Administrative Clerk
Gloria J. Maender, Editorial Assistant

(602) 670-6885
(602) 621-1174
FTS (602) 670-6885

Reports in the Natural Resources Technical Report (NRTR) Series are produced in limited quantities. As long as the supply lasts, copies may be obtained from the Cooperative National Park Resources Studies Unit, NPS—CPSU/UA, 125 Biological Sciences East, The University of Arizona, Tucson, AZ 85721. Reports are also available (a copy charge may be involved) upon request by mail or phone (303-969-2130) from the NPS Technical Information Center (TIC), Attn: DSC-PGT, P.O. Box 25287, Denver, CO 80225-0287. *This report was printed on recycled paper.*

---

[1] Phillips is now a Zone Botanist with Coconino, Kaibab and Prescott National Forests, 2323 E. Greenlaw Lane, Flagstaff, AZ 86004.

CONTENTS

FIGURES AND TABLES

Figures

Tables

ACKNOWLEDGEMENTS

I would like to thank biologist Karen Reichhardt for the opportunity to spend five wonderful spring days hiking in such a spectacular monument. Especial thanks also to Kathy Davis of the Southern Arizona Group (SOAR) for facilitating the project and hiking with me to Upper Ruin. Carol Kruse, former superintendent at Tonto National Monument, and her staff were helpful in many ways including providing a place to throw a sleeping bag and a shower after a hot day in the field. Faye Morrison and Eddie Colyott offered many ideas from their years of experience at the monument, and Eddie was very pleasant company on the Deadman Canyon hike.

ABSTRACT

A survey for non-native plant species was conducted in Tonto National Monument, western Gila County, Arizona, between March 23 and 27, 1988, and on November 19, 1988. Thirteen species were recorded during this survey, three of which were noted for the first time. Five species previously recorded were not seen. Transects were hiked throughout the monument with efforts concentrated on areas where disturbance by humans has been intense, such as along roads, trails, burned areas and fire breaks, and areas revegetated after fires. In addition, some of the backcountry was hiked to estimate degree of disturbance and to look for possible introduction of non-natives by domestic livestock. Each area hiked was discussed separately, with emphasis on the non-natives present and degree of disturbance of native vegetation. Changes in the presence and relative abundance of several species were discussed, as well as management alternatives for selected non-native species.

INTRODUCTION

Tonto National Monument (TONT) was founded to provide protection and interpretation of several archeological sites, including two ruins of Salado Culture pueblos designated as Upper and Lower ruins. In addition, the monument has rich succulent desert vegetation of the Arizona Upland Subdivision of the Sonoran Desertscrub (Brown and Lowe 1980). There is an admixture of chaparral-type shrubs (predominantly jojoba [*Simmondsia chinensis*]) and a scattering of one-seed juniper (*Juniperus monosperma*) on the higher slopes in the southwestern corner of the monument (Burgess 1965). A small area of mesic deciduous forest dominated by Arizona sycamore (*Platanus wrightii*) occurs in Cave Canyon, the major drainageway traversing the monument from south to north. Thus, there is a variety of habitats for plants, and Burgess found 265 species growing within the boundaries of the small monument (450 ha [1,120 a]).

A comparison of TONT plants recorded by Strong ([1962] cited in Brian [1991]) and Burgess (1965) with those of Montezuma Castle National Monument (MOCA) showed TONT to be remarkably free of roadside and agricultural weeds. Perhaps a dozen non-native species were growing at TONT at that time (1960s) while four times as many were present at MOCA. Burgess (1965) attributed this to two situations: (1) the greater traffic through MOCA for a longer period of time (TONT has been somewhat isolated from main highway routes, while MOCA has been readily accessible); and (2) the contiguity of MOCA with large areas of farmland along the floodplain of Beaver Creek, areas that have probably been in cultivation since pre-Columbian times.

Tonto National Forest (of which the monument area was a part until 1933) had a long history of being a seriously overgrazed and abused rangeland (Croxen 1926). From about 1875 to 1904 the "range was not only grazed out but trampled out as well . . . After the great herds of cattle had grazed over the Salt River country, there was not rooted grass, only browse and annuals remaining" (Croxen 1926). In 1941, 290 ha (720 a) of TONT were fenced, excluding domestic livestock but permitting access to the area by desert mule deer (*Odocoileus hemionus crooki*), whitetail deer (*Odocoileus virginianus*), and javelina (*Dicotyles tajacu*). In 1976, all grazing agreements were terminated. However, trespass grazing continued until November 6, 1981, when boundary fences were completed (Tonto National Monument files 1976, 1981).

Several fires burned portions of TONT from 1947 to the mid-1980s. In late June and early July 1964 (June 27-July 2) TONT and surrounding parts of the Tonto National Forest were burned by natural wildfire (Schulze Fire). The fire burned onto the monument on July 1 and by nightfall had blackened 220 ha (540 a) (Tonto National Monument files 1964). It was contained by 10 p.m.

In July 1970, 80 ha (200 a) burned on the monument. On May 18, 1976, a fire burned 100 ha (250 a) on the monument in Cave Canyon and very close to the housing area.

Another major fire occurred in July 1980 (40 ha [100 a]), burning Cave Canyon, Honey Butte, and the area around and above Upper Ruin. The burned area was seeded with confiscated jojoba nuts in August. On July 25, 1976, 0.8 ha (2 a) burned in the Deadman Canyon area. Other small fires were recorded in August 1973 (0.8 ha [2 a]), July 1974 (0.4 ha [1 a]), August 1979 (0.4 ha [1 a]), July 1983 (1.2 ha [3 a]) and July 1984 (0.4 ha [1 a]) (Tonto National Monument files 1970-1984). A resurvey of the 1961 line intercept transects of Strong ([1962] cited in Brian [1991]) by Brian (1991) through a portion of the burned area indicated that changes in the plant community structure have occurred, some of which might be attributable to these fires.

Concerns about the impacts of fires and prolonged grazing on native plant species at TONT have prompted the present survey. This is a preliminary determination of how widespread and problematic non-native species have become. Management alternatives for selected non-native species are offered.

METHODS

Transects were hiked throughout the monument between March 23 and 27, 1988, and on November 19, 1988, and marked on topographic maps. Since the purpose of this survey was to locate non-native plants, efforts were concentrated on areas where disturbance by humans has been intense, such as along roads and trails, around buildings, on burned areas and fire lines, and areas revegetated after fires. In addition, some of the backcountry was hiked to estimate the degree of disturbance and to look for possible introduction of non-natives by domestic livestock. Non-native plants were noted as they were found and collected on initial encounter to verify identification. The general location and relative abundance of each non-native species was recorded.

Scientific nomenclature and common names follow Lehr (1978) and Lehr and Pinkava (1980, 1982). Phenological information is from Kearney and Peebles (1960; supplemented by pers. obs.).

RESULTS

Figure 1 shows the major physical features of TONT mentioned in the text. Transects hiked and areas surveyed are shown on Figures 2 and 3, respectively. Major areas discussed are (1) the trail to Upper Ruin (including the Mesic Forest [Burgess designation]), (2) the trail to Lower Ruin, (3) Cholla Canyon, (4) the monument road, (5) the ridge in the southeast corner of the monument, (6) Cave Canyon Wash, (7) the area northeast of Arizona Highway 88, and (8) the Deadman Canyon hike. Table 1 presents each non-native species found and its general location, abundance, and phenology. Appendices 1-8 show the locations of several of the non-native plant species; locations for the remaining species were more limited and are described in the text.

TRAIL TO UPPER RUIN

The trail to Upper Ruin first goes through the Mesic Forest of Arizona sycamore, Arizona walnut (*Juglans major*), hackberry (*Celtis reticulata* and *Celtis pallida*), and elderberry (*Sambucus* spp.). Wild cucumber (*Marah gilensis*) was the common vine trailing over trees and fences in this area. A very large patch of the non-native common horehound (*Marrubium vulgare*) occurred south of the creek in an open area between the walnuts and hackberries, along with miner's lettuce (*Claytonia perfoliata*). Further along the trail, where Arizona dewberry (*Rubus arizonensis*) has been cut down around the spring in the drainage bottom, several introduced weeds, including common horehound, shepherd's purse (*Capsella bursa-pastoris*), and annual yellow sweet clover (*Melilotus indicus*), were growing. Another non-native, annual sow thistle (*Sonchus oleraceus*), was collected near the spring and along Upper Ruin Trail.

Common horehound was also abundant below the spring, scattered in the more open creek area below the limit of Arizona sycamore, and abundant under western honey mesquites (*Prosopis glandulosa* var. *torreyana*) at the junction of the trail with the monument road. Blue wild rye (*Elymus glaucus*) was very abundant in the Mesic Forest and the non-native wild oat (*Avena fatua*) was locally common. Introduced wild barley (*Hordeum leporinum*) occurred around the algae-covered trough in the hackberry "forest." Introduced ripgut grass (*Bromus rigidus*) was abundant under the hackberries.

The non-native filaree (*Erodium cicutarium*) occurred as a mat underfoot all along the trail to Upper Ruin. In the desert along the trail, the non-native red brome (*Bromus rubens*) was very dense almost everywhere. Introduced Boer lovegrass (*Eragrostis chloromelas*) and Lehmann's lovegrass (*Eragrostis lehmannii*) (both species seeded after fires) were dominant in the switchback area of the trail along the southern boundary of the monument across the desert to the north below Upper Ruin.

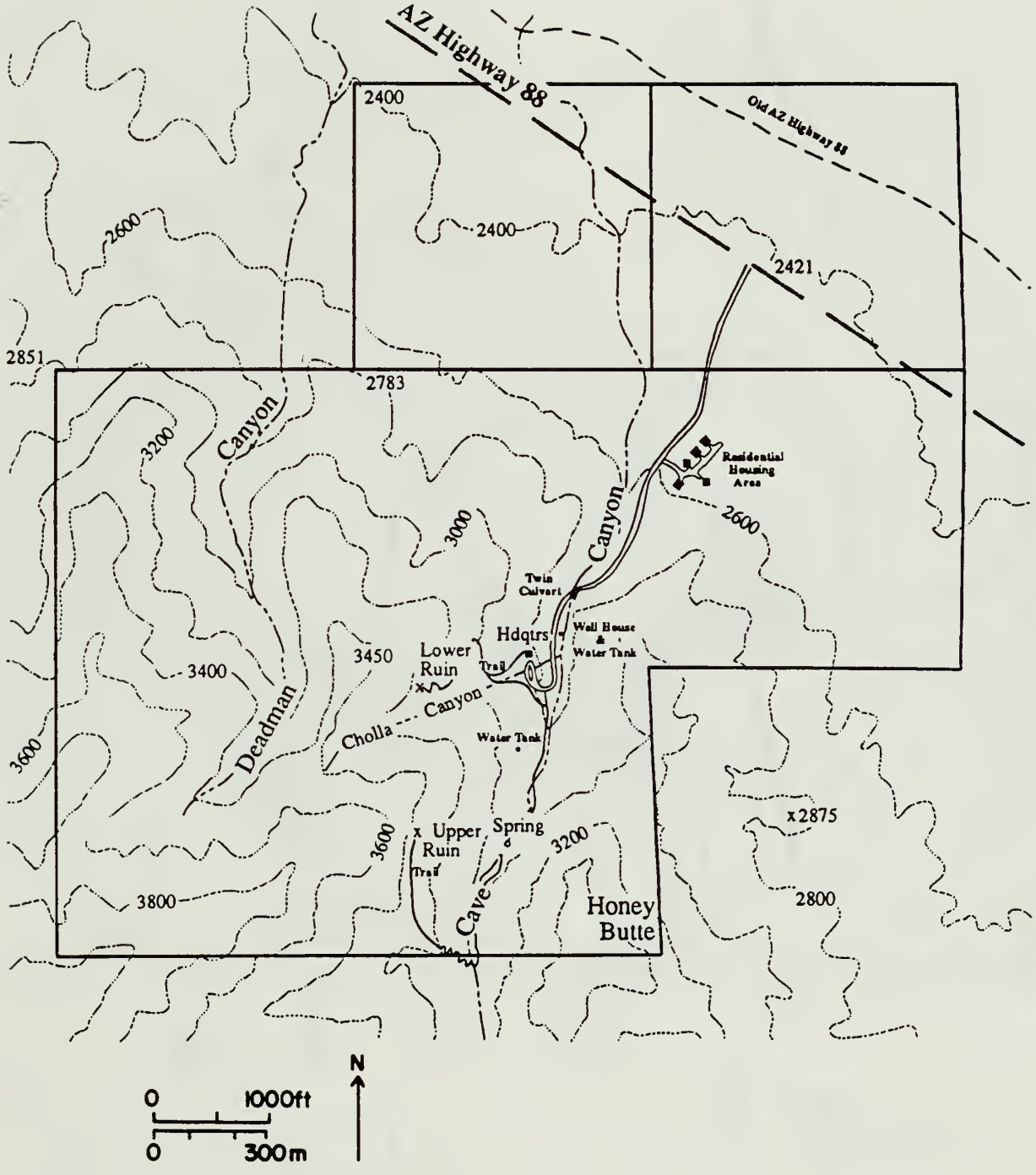


Figure 1. Tonto National Monument, Arizona.

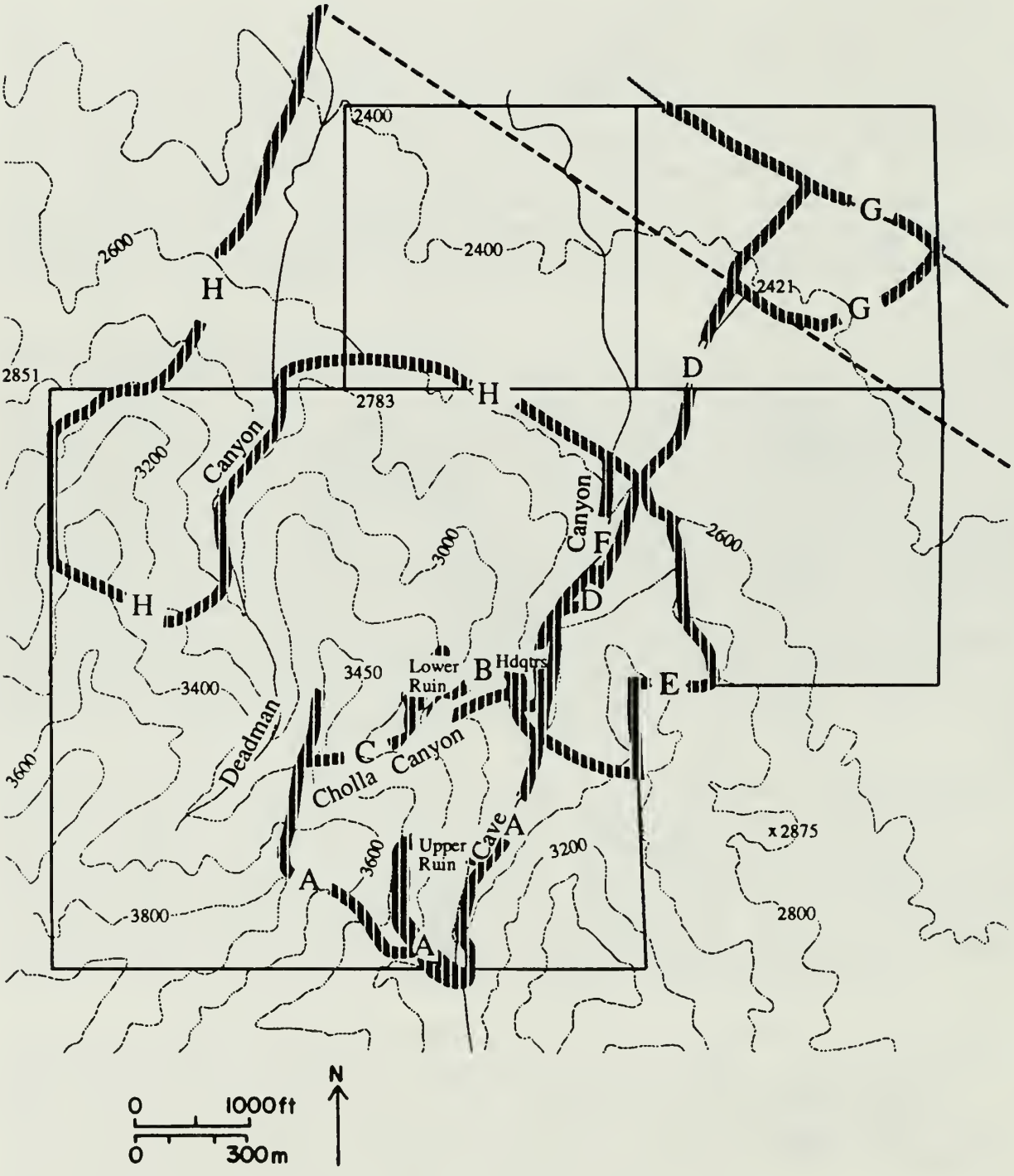


Figure 2. Transects (A-H) hiked at Tonto National Monument, Arizona, in 1988.

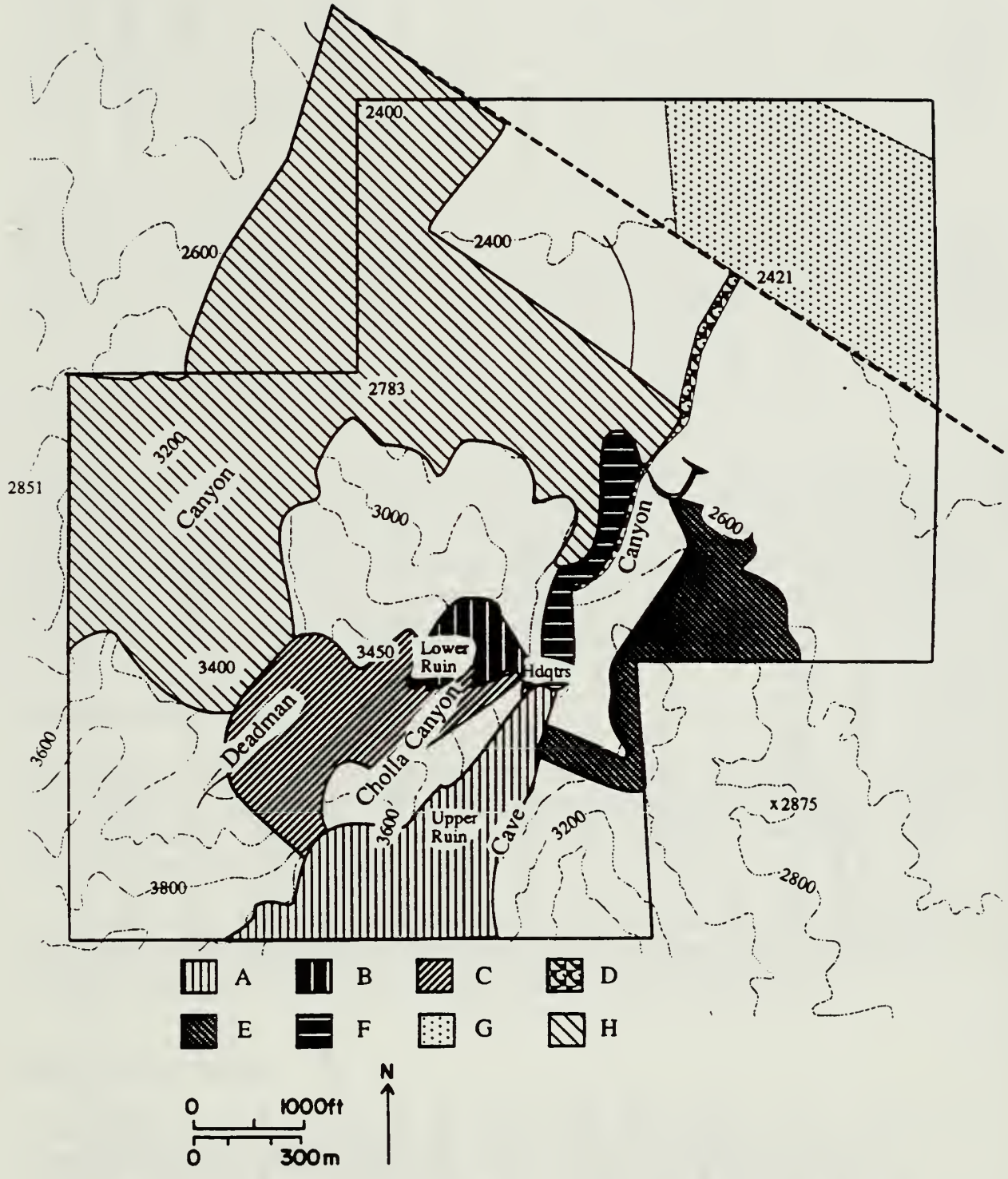


Figure 3. Areas (A-H) surveyed at Tonto National Monument, Arizona, in 1988.

Table 1. Non-native plant species of Tonto National Monument, Arizona, 1988.

Name	Location	Abundance	Flowering season
Wild Oat *Avena fatua*	Mesic Forest and Cave Canyon Wash under trees	locally common	March to July
Ripgut Grass *Bromus rigidus*	Mesic Forest and Cave Canyon Wash; Lower Ruin Trail, under trees	locally abundant	spring
Red Brome *Bromus rubens*	ubiquitous on open desert slopes	very abundant	spring
Shepherd's Purse *Capsella bursa-pastoris*	disturbed areas	locally abundant	spring
Boer Lovegrass *Eragrostis chloromelas*	desert slopes along Upper Ruin Trail	locally common	summer
Lehmann's lovegrass *Eragrostis lehmannii*	desert slopes along Upper Ruin Trail	locally common	summer
Filaree *Erodium cicutarium*	mat on Upper Ruin Trail; scattered elsewhere	locally abundant	February to July
Wild Barley *Hordeum leporinum*	Mesic Forest; disturbed areas	infrequent	April to June
Common Horehound *Marrubium vulgare*	Mesic Forest; Cave Canyon Wash; disturbed areas	locally abundant	April to September
Annual Yellow Sweet Clover *Melilotus indicus*	scattered roadsides	infrequent	April to September
Mediterranean Grass *Schizmus barbatus*	desert slopes	locally abundant	spring
Spiny Sow Thistle *Sonchus asper*	scattered Cholla Canyon; backcountry desert	occasional	February to August
Annual Sow Thistle *Sonchus oleraceous*	scattered Mesic Forest	occasional	March to September

Desert needlegrass (*Stipa speciosa*), a native bunchgrass, was dominant above the band of lovegrass to the top of the ridge and formed yellow patches in March elsewhere in the monument, especially in unburned areas and on north-facing slopes. Native three-awns (*Aristida* spp.) were found part way up the switchbacks and occurred frequently along the trail thereafter; they were dominant on the desert slope between Upper Ruin and Cave Creek. In the small drainage south of the saguaros (*Carnegiea gigantea*) below Upper Ruin (saved from fire by fire line), red brome and wild oat were abundant.

On top of the hill above Upper Ruin is a very open windswept habitat that becomes boggy in February and also in July and August after rains (Colyott 1988, pers. com.). Fire has passed through there several times (Tonto National Monument files 1941-1988). Shrubs and cacti were very scattered, with less than 5% cover. Red brome was dominant on the south-facing slope. Some Boer lovegrass was found growing here; filaree was also seen.

TRAIL TO LOWER RUIN

Other than the ubiquitous red brome, the only non-natives encountered along the trail to Lower Ruin were a few patches of ripgut grass and wild oat. This area has been protected from fire since 1964. Filaree occurred only occasionally, because the path was paved. It was common only in the scraped area around the bench at 915 m (3,000 ft). One non-native spiny sow thistle (*Sonchus asper*) was seen along the trail. The trail to Lower Ruin was paved in 1974 (Tonto National Monument files 1974).

CHOLLA CANYON

Cholla Canyon was accessed by hiking down a side drainage below Lower Ruin where teddy bear cholla (*Opuntia bigelovii*) and jojoba grew abundantly. The only non-natives seen while walking up the drainage were red brome (which was everywhere) and occasional spiny sow thistle plants.

A second hike was made up Cholla Canyon from the bottom at the visitor center in November to look specifically for the introduced tree tobacco (*Nicotiana glauca*) recorded from there in 1961, but the plant was not found on either hike.

MONUMENT ROAD

Proceeding from the main highway (Arizona 88) up the monument road to the visitor center, we found the roadside lined with mostly native early seral plants such as snakeweed (*Gutierrezia microcephala*), slimleaf bursage (*Ambrosia confertiflora*), thistle (*Cirsium meomexicanum*), and annuals. Red brome and annual yellow sweet clover were

also present. Wild oat occurred occasionally along the road under mesquite, as did common horehound and wild barley.

At the well house (building no. A [04-12] 34 ADD), there was quite a lot of common horehound and a patch of wild barley, and shepherd's purse grew behind the building toward Cave Creek. Filaree and red brome were present.

A 189,250-litre (50,000-gal) water tank was constructed in 1963 near the big cottonwood tree (now dead and down) just south of the twin culvert in Cave Canyon. A septic tank was constructed just west of the twin culvert (Tonto National Monument files 1941-1988). Filaree, shepherd's purse, red brome, and wild barley were growing on top of the tanks.

In 1966, the parking strip by the visitor center (which had remained barren for 16 years) was landscaped with native plants (Tonto National Monument files 1966). For the most part this area is free of non-natives, although some red brome and common horehound were observed.

RIDGE IN SOUTHEAST CORNER OF MONUMENT

With the exception of red brome, the vegetation on the north-facing hillside consisted of native desert species. Snakeweed was dominant along with jojoba and catclaw acacia (*Acacia greggii*), with miner's lettuce and Indian wheat (*Plantago* spp.) underneath. Other species included ocotillo (*Fouquieria splendens*), prickly pear cactus (*Opuntia phaeacantha*), Parish viguiera (*Viguiera deltoidea* var. *parishii*), Fremont thornbush (*Lycium fremontii*), blue dicks (*Dichelostemma pulchellum*), and desert bedstraw (*Galium stellatum*). Some of the catclaw acacia had been damaged by fire but was recovering. Javelina appeared to be digging for tubers of wild cucumber.

Toward the top of the ridge there was a lot of bare ground and much more evidence of fire damage. Introduced wild barley grew in rocks at the top along with a large patch of desert tobacco (*Nicotiana attenuata*). Teddy bear cholla, brittlebush (*Encelia farinosa*) and foothill palo verde (*Cercidium microphyllum*) had sustained fire damage but were recovering. Other shrubs were very small. Cane cholla (*Opuntia acanthocarpa*) and saguaros were killed by the fire. On the east-facing burned slope, jojoba was dominant with red brome and the occasional globe mallow (*Sphaeralcea ambigua*). A slimleaf bursage swath ran through the teddy bear cholla patch where it was growing on a former fire line.

In contrast, on the south-facing slope where no (or limited) fire occurred, brittlebush, teddy bear cholla, saguaro and foothill palo verde were dominant. A very lush area of desert species also occurred in a north-facing drainage where firebreaks had kept out the fire.

The firebreak scar down the west-facing slope from the saddle northeast of Honey Butte was reported to have been revegetated with native species (Tonto National Monument files 1941-1988); we found mainly early seral native species such as snakeweed, desert rock pea (*Lotus rigidus*) and three-awns.

CAVE CANYON WASH

In Cave Canyon Wash west of the residential housing area up drainage to the monument road crossing, wormwood (*Artemisia dracunculus*) was abundant. Native trees and shrubs such as foothill palo verde, jojoba, brittlebush, catclaw acacia, western honey mesquite, desert broom (*Baccharis sarothroides*), and perennial herbs such as globe mallow, desert marigold (*Baileya multiradiata*), desert rock pea, odora (*Porophyllum gracile*) and desert bedstraw were common. The non-natives wild oat, ripgut grass and red brome were also locally abundant.

Wild Oat became more abundant upon going up drainage, especially under trees. Beyond the point where the telephone line to the visitor center crossed the creek, the first common horehound was seen in the wash. At the twin culverts and "dam," common horehound and wild barley dominated, along with shepherd's purse.

In the creekbed on the south side of the monument road, the same vegetation occurred. Parish viguiera and snakeweed grew on small terraces adjacent to the creek. This open bouldery wash had a number of herbs, especially wormwood, in the center, with trees and shrubs on the banks. Occasionally, the creekbed was closed in with catclaw acacia and mesquite.

NORTHEAST OF ARIZONA HIGHWAY 88

The dirt road that parallels Arizona Highway 88 is the original route of this highway. Along it snakeweed (*Gutierrezia microcephala*) was common, and filaree and slimleaf bursage (were present. The main species on the flats in the area northeast of the highway were foothill palo verde, jojoba, Fremont thornbush, western honey mesquite, and catclaw acacia with red brome and globe mallow in the understory. The cacti were prickly pear cactus, teddy bear cholla and cane cholla. The light green "open" areas visible in this area from the visitor center were covered with native Indian wheats.

Wild oat grew along the drainages by old Highway 88, and a fairly large patch of annual yellow sweet clover was growing beside the road where the soil had been scraped. Wild oat also occurred by the culvert at milepost 246 and in the ditch along the current Arizona Highway 88. Wild barley and annual yellow sweet clover were present half way to the south boundary of the monument along the dirt road. No Russian thistle (*Salsola*

ibirica) was seen during the March or November search of this area, although it had been collected on the monument in 1961.

DEADMAN CANYON HIKE

A backcountry hike was made into the Deadman Canyon area to check for the presence of non-natives along the north-facing slopes and canyon areas that were not fenced from domestic livestock until 1976. No non-natives were observed, however, except red brome, a few spiny sow thistles (along a wildlife trail), and two wild oat plants.

After heading directly southwest from the highway toward the butte on the west side of Deadman Canyon, we followed the northern fence line (for the most part) around the butte until the western fence line was met. Pre-historic Indians gardened and terraced the lower slopes. Miner's lettuce grew abundantly, and there was a lot of rock echeveria (*Dudleya saxosa* ssp. *collomiae*) on the very rocky, steep, north-facing slopes. Native grasses such as the three-awns, desert needlegrass and other needlegrasses, grama grass (*Bouteloua* spp.) and six-weeks fescue (*Vulpia octoflora*) were dominant on north-facing slopes rather than red brome. Much disturbance was evident; javelina trails and dig holes occurred everywhere on the upper slopes on the north side where these animals frequent alcoves under the butte.

We then proceeded south up a steep slope until a saddle was reached, descended Deadman Canyon, and hiked downstream to the north boundary fence. Lush desert vegetation was encountered on the Mescal limestone soil (Raup n.d.) of the western slope where spike moss (*Selaginella arizonica*) comprised almost 50% of the ground cover, and red brome occupied the remaining 50%. After the descent into Deadman Canyon, we contoured around the terraces at about the 790 m (2,600 ft) elevation to the monument road.

DISCUSSION

Tonto National Monument is still remarkably free of non-native plant species. Thirteen species were recorded during this survey. Red brome was the most prevalent and potentially most threatening, since its presence as a ground cover in the Sonoran Desert (and almost probably at TONT) has resulted in disastrous fires where formerly there was insufficient herbaceous cover to carry fire (Rogers and Steele 1980). Dead or overly mature red brome is a readily available fuel easily ignited by lightning or humans. It supports fast-moving fires.

Two other non-native species could be considered "highly undesirable." Ripgut grass was locally abundant under trees and shrubs and presents the same potential danger as red brome. Common horehound occurred in massive patches in some locations (especially in the Mesic Forest), occupying habitat that could be used by native species and is unsightly during senescence. It has probably increased considerably in abundance in the past 25 years since Burgess (1965) noted it as "scattered" in the Mesic Forest.

Wild barley may not be increasing to any great extent. Burgess noted it as "scattered in the desert, more abundant in disturbed areas," and the herbarium label stated it as occurring on the "ridge south of [the] residential area and scattered trails and roads." The herbarium specimen label stated the plant occurred "along trail through cactus patch near parking lot; Lower Ruin trail." Apparently, wild oat is increasing in abundance for it is now found in fair abundance along the Upper Ruin Trail in the Mesic Forest, and elsewhere under trees along drainageways.

Five non-native species recorded for the monument were not found in this survey. Three were specifically searched for: tree tobacco, Russian thistle, and London rocket (*Sisymbrium irio*). Two non-native grasses not found but previously recorded (Burgess 1965)—Chilian chess (*Bromus trinii*) and stink grass (*Eragrostis cilianensis*)—could easily have been missed due to the short time spent in the field.

The TONT herbarium specimen label said that tree tobacco was collected in Cholla Wash at 885 m (2,900 ft), growing in full sun on rocky soil in 1961. It was not seen in either the March or November 1988 searches, but between 1961 and 1988 at least one fire burned through the canyon, and a fire break has been cut. The plant from which the specimen was taken could also have died naturally. Tree tobacco was in flower and highly visible in November along Arizona Highway 88.

The 1961 collection label for Russian thistle stated "Tonto National Monument, roadside." An annual, it might have been too young in March to be noticeable, but it was specifically searched for in November, especially along old Highway 88, and was not found. If Russian thistle did occur at one time along the old dirt road, it probably does

not do so now, because a long period has passed since disturbance. The species was very obvious along the Roosevelt Lake shoreline in November.

The 1962 London rocket label read, "ridge south of residential area and common in disturbed places along trails and roadsides. Elevation ca. 2,600 feet." This species was not found on the ridge in March 1988. It also was specifically searched for along roads in the housing area in November 1988 but was not found there.

CONCLUSION AND MANAGEMENT RECOMMENDATIONS

Thirteen species of non-native plants were recorded, three for the first time, in a survey conducted at TONT from March 23-27, 1988, and on November 19, 1988. Transects hiked concentrated on areas of human disturbance, areas revegetated after fires, and areas where livestock might introduce species. Management alternatives for selected non-native species are discussed in the following paragraphs.

Removing the large patches of common horehound by "grubbing out" before flowering commences would eliminate the seed sources. Pulling only plants growing beside trails probably would prove to be ineffective management.

Where scraping or other manipulation of desert soils is planned, surface "topsoil" (upper 2-5 in.) should be saved and replaced on the disturbed area after scraping or construction. The seeds in this surface layer will provide for natural regeneration of native species.

Where construction projects, old fire scars, or fire breaks exist, plantings of native species of shrubs and cacti are recommended. Although the fire lines on the slopes south of the visitor center had been planted with native species, the diversity at the time of this study was not very great; additional native species could be planted.

A program to systematically trim the leaves and flowering stalks of lovegrasses (to prevent flowering) growing along the Upper Ruin Trail could be implemented for a number of years during the growing season. Pulling up or digging up the established plants would probably cause erosion because of the steepness of the slope. However, by systematically eliminating the seed source, these introduced perennial grasses might gradually be replaced by native species (which occur abundantly above and adjacent to the area) by natural attrition. Periodic broadcasting of native seeds might speed the replacement process.

Since fire has been a prominent force on the vegetation of TONT, there is great potential for doing a comparison study of the impacts of fire on the ecology of the Upper Sonoran Desert at this site (Phillips 1988). Little is known about the ecological role of fire in the Sonoran Desert (Rogers and Steele 1980), and until fairly recently the impact of fire on desert vegetation was thought to be minimal (Phillips 1962; Humphrey 1974) due to lack of ground cover to ignite or carry fire. However, widespread distribution of the non-native red brome has led to unnaturally frequent fires in recent years that have resulted in local loss of native plants, increase of the non-native component, and change in vegetation structure. Fire could become a significant selective force in shaping the life-history traits of individual species and strongly influence the community structure of the desert, depending upon fire severity and frequency (Phillips 1988).

LITERATURE CITED

Brian, N. 1991. Resurvey of 1961 line intercept transects at Tonto National Monument, Arizona. National Park Service, Cooperative Park Studies Unit Technical Report No. 38, The University of Arizona, Tucson, Arizona. 67 p.

Brown, D. E., and C. H. Lowe. 1980. Map, biotic communities of the Southwest (scale 1:1,000,000). USDA Forest Service General Technical Report RM-78, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Burgess, R. L. 1965. A checklist of the vascular flora of Tonto National Monument, Arizona. Journal of the Arizona Academy of Science 3:213-223.

Croxen, F. W. 1926. History of grazing on Tonto. Presented to the Tonto Grazing Conference in Phoenix, Arizona, November 4-5, 1926, by Senior Forest Ranger, F. W. Croxen. Unpublished manuscript. 11 p.

Humphrey, R. R. 1974. Fire in the deserts and desert grassland of North America. Pages 365-400 in T. T. Kozlowski and C. E. Ahlgren. Fire and ecosystems. Academic Press, New York.

Kearney, T. H., and R. H. Peebles. 1960. Arizona flora, 2nd ed. with supplement. University of California Press, Berkeley. 1,085 p.

Lehr, J. H. 1978. A catalogue of the flora of Arizona. Desert Botanical Garden, Phoenix, Arizona. 203 p.

Lehr, J. H., and D. J. Pinkava. 1980. A catalogue of the flora of Arizona supplement I. Journal of the Arizona-Nevada Academy of Science 15:17-32.

Lehr, J. H., and D. J. Pinkava. 1982. A catalogue of the flora of Arizona supplement II. Journal of the Arizona-Nevada Academy of Science 17:19-26.

Phillips, B. G. 1988. History of fire and its impacts at Tonto National Monument. Research proposal submitted to Southwest Parks and Monuments Association, June 1988.

Phillips, W. S. 1962. Fire and vegetation of arid lands. Pages 81-93 in Proceedings of first annual Tall Timbers fire ecology conference, Tallahassee, Florida, March 1-2, 1962. Tall Timbers Research Station, Tallahassee, Florida.

Raup, R. B., Jr. N.d. Some geologic features of the Tonto National Monument, Gila County, Arizona. Unpublished manuscript in Tonto National Monument files.

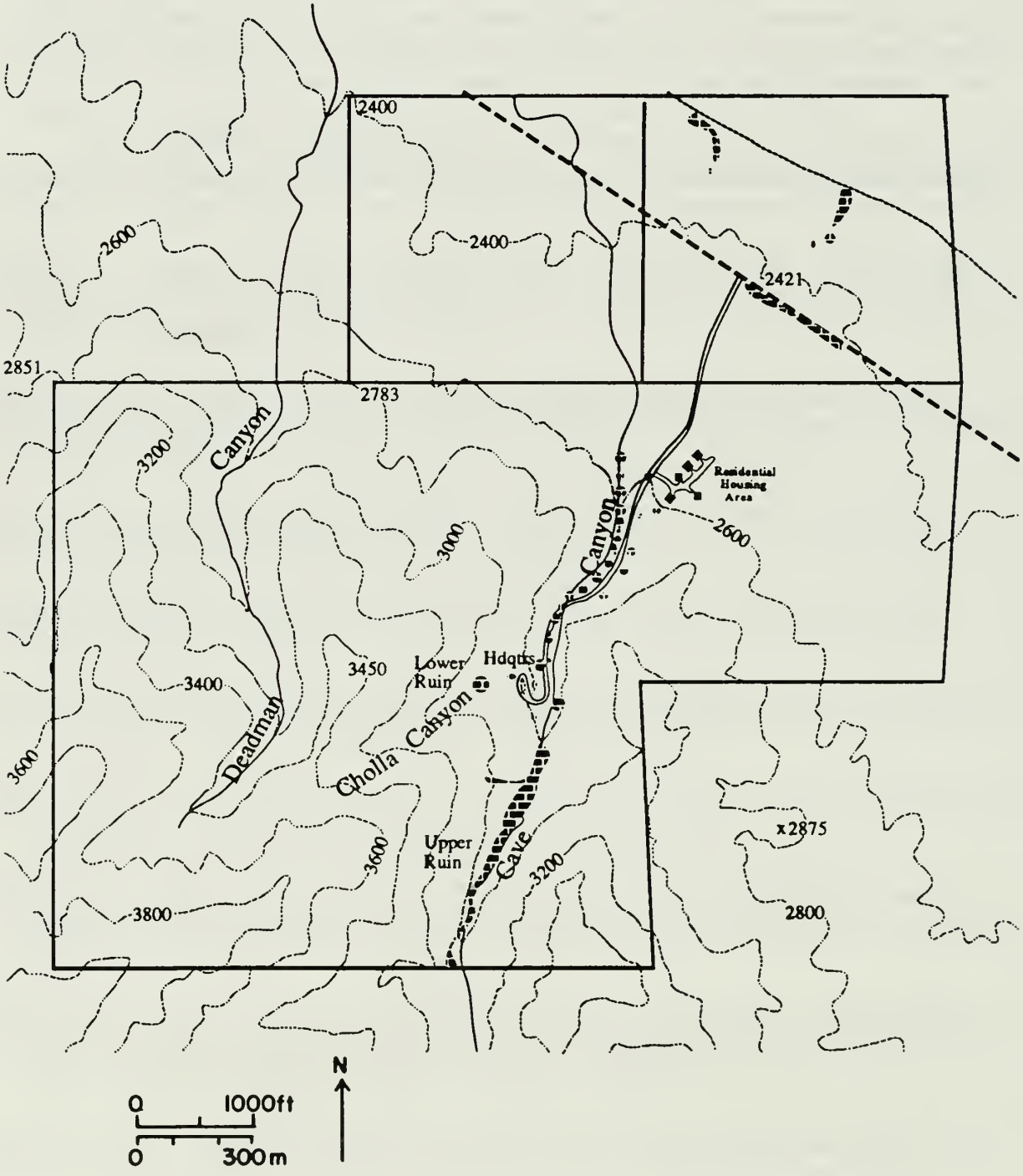
Rogers, G. and J. Steele. 1980. Sonoran Desert fire ecology. In M. A. Stokes and J. H. Dieterich (tech. coord.). Proceedings of the fire history workshop October 20-24, 1980, Tucson, Arizona. USDA Forest Service General Technical Report RM-81. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Strong, C. W. 1962. Untitled report. Pages 29-67 in Nancy J. Brian. Resurvey of 1961 line intercept transects at Tonto National Monument, Arizona. National Park Service, Cooperative Park Studies Unit Technical Report No. 38, The University of Arizona, Tucson, Arizona. 67 p.

Tonto National Monument. 1941-1988 files. [This information was obtained from a variety of sources such as annual reports and project reports contained in the library at Tonto National Monument].

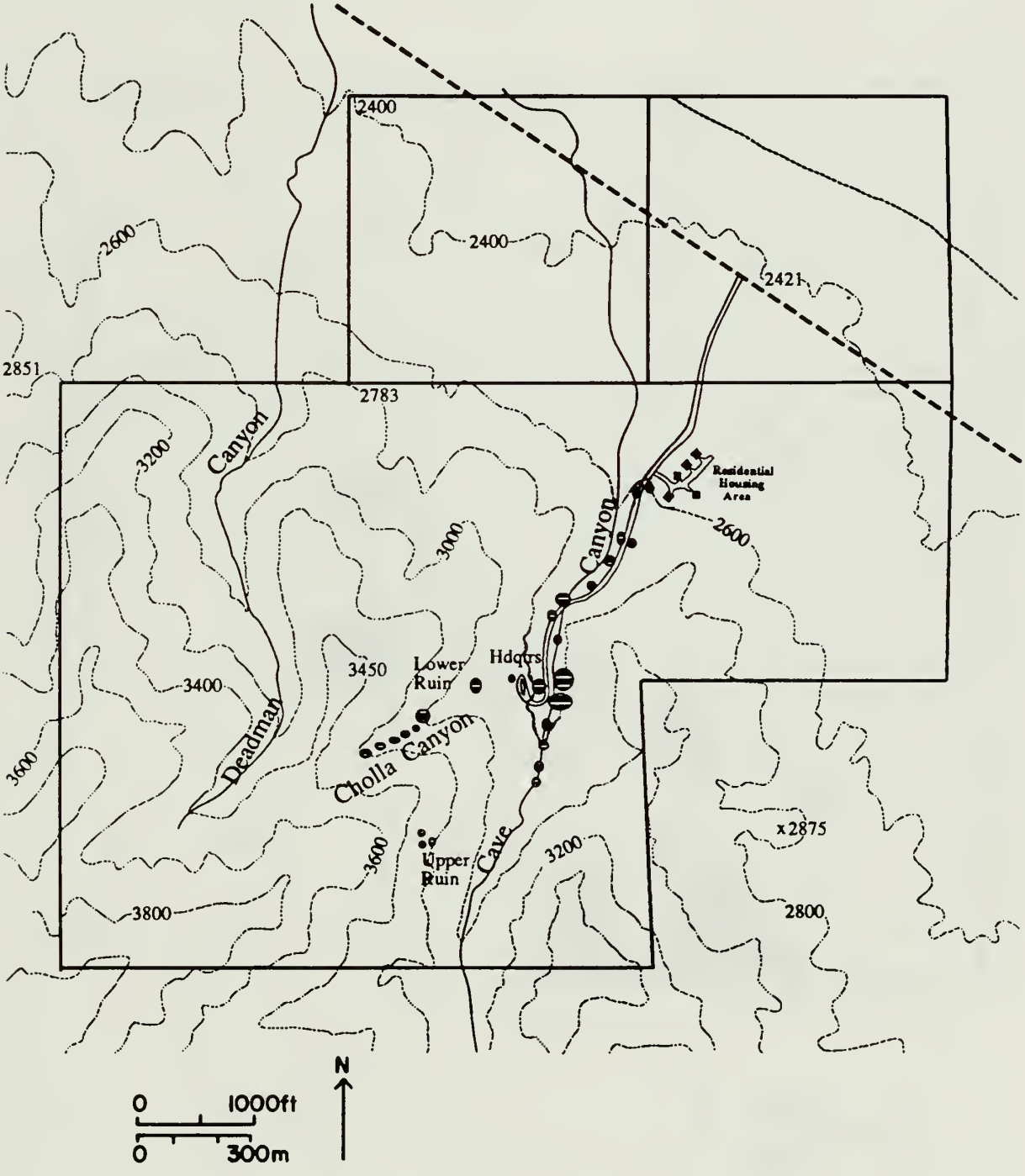
APPENDIX 1

LOCATIONS OF WILD OAT (*AVENA FATUA*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



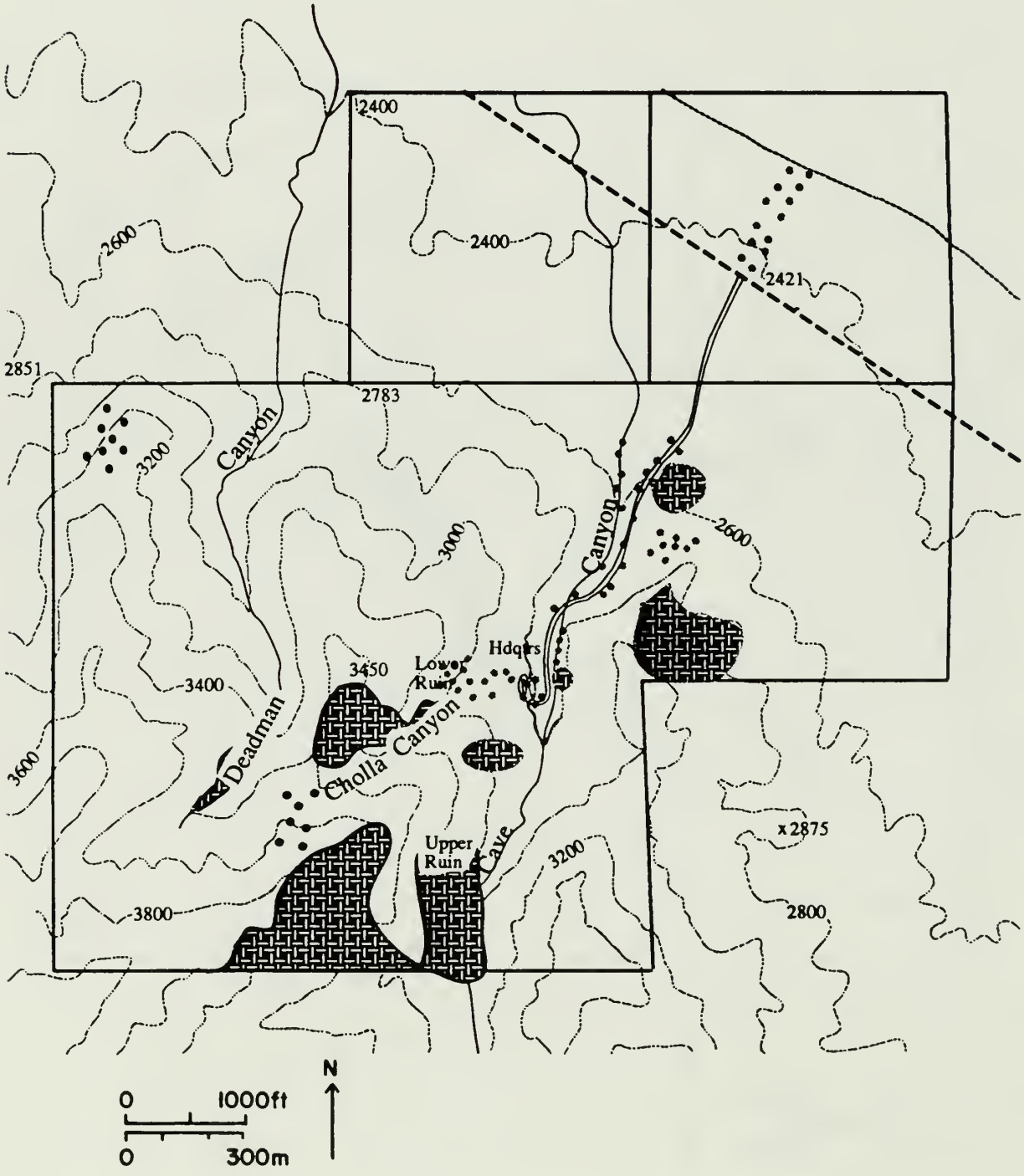
APPENDIX 2

LOCATIONS OF RIPGUT GRASS (*BROMUS RIGIDUS*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



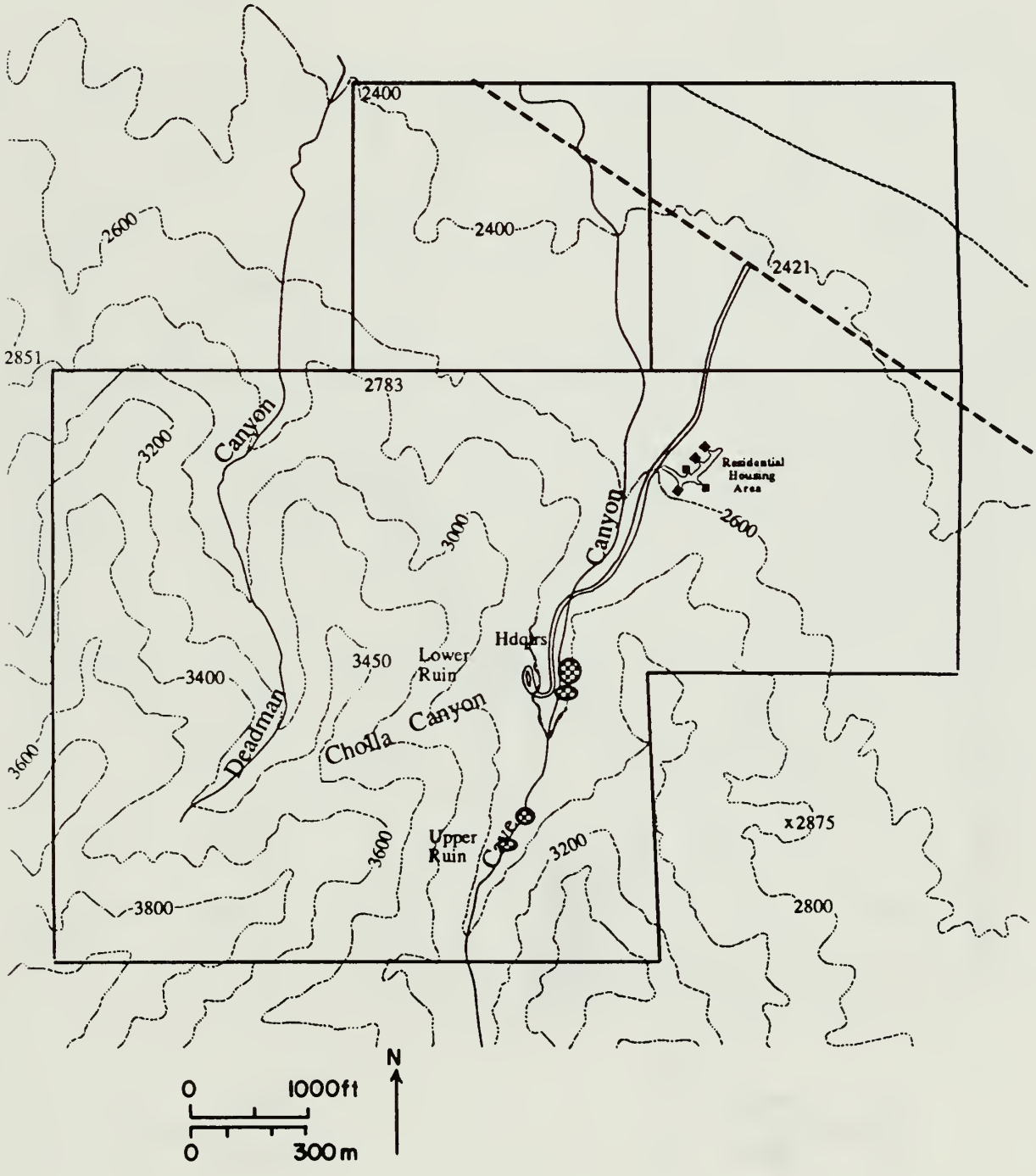
APPENDIX 3

LOCATIONS OF RED BROME (*BROMUS RUBENS*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



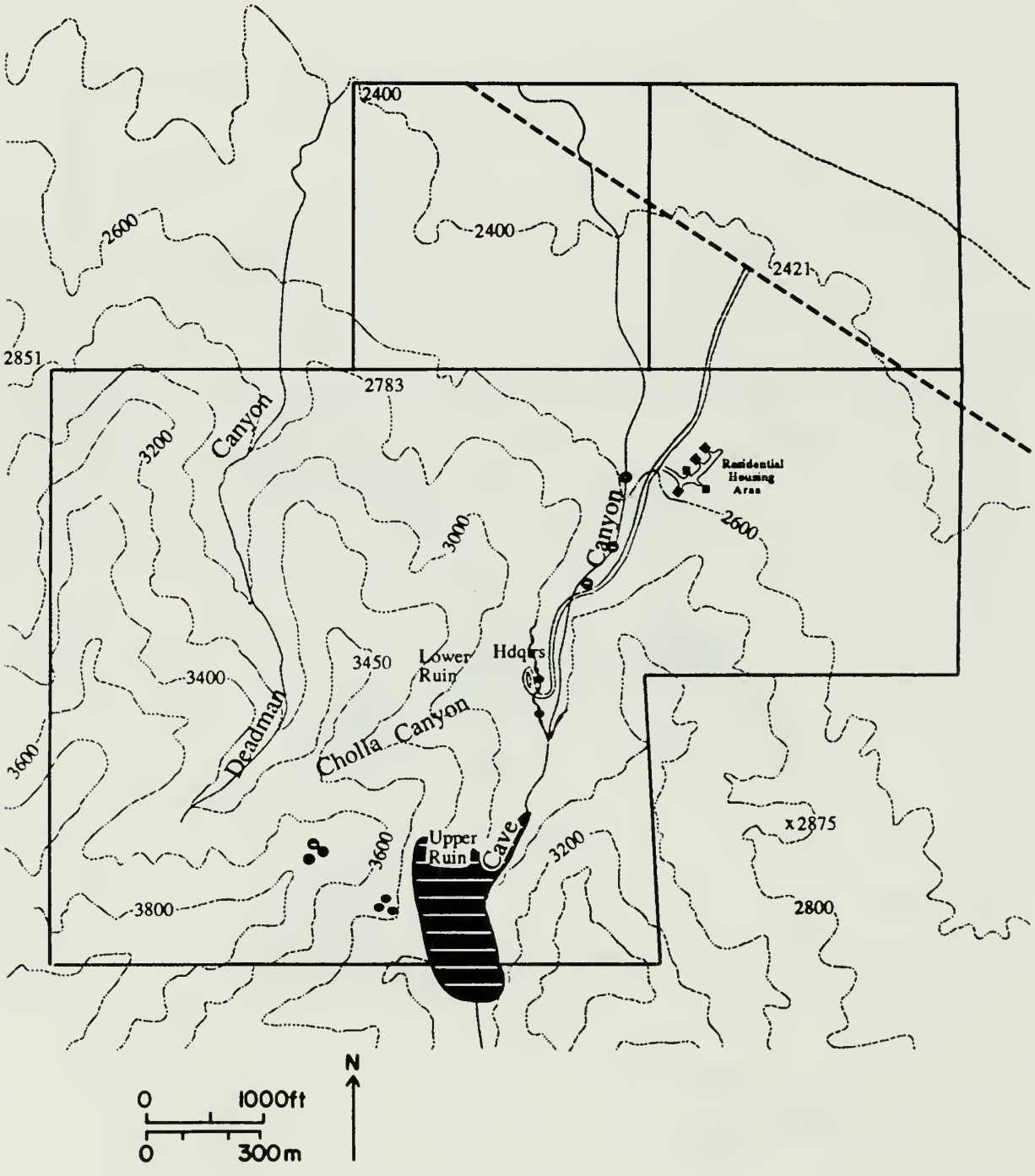
APPENDIX 4

LOCATIONS OF SHEPHERD'S PURSE (*CAPSELLA BURSA-PASTORIS*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



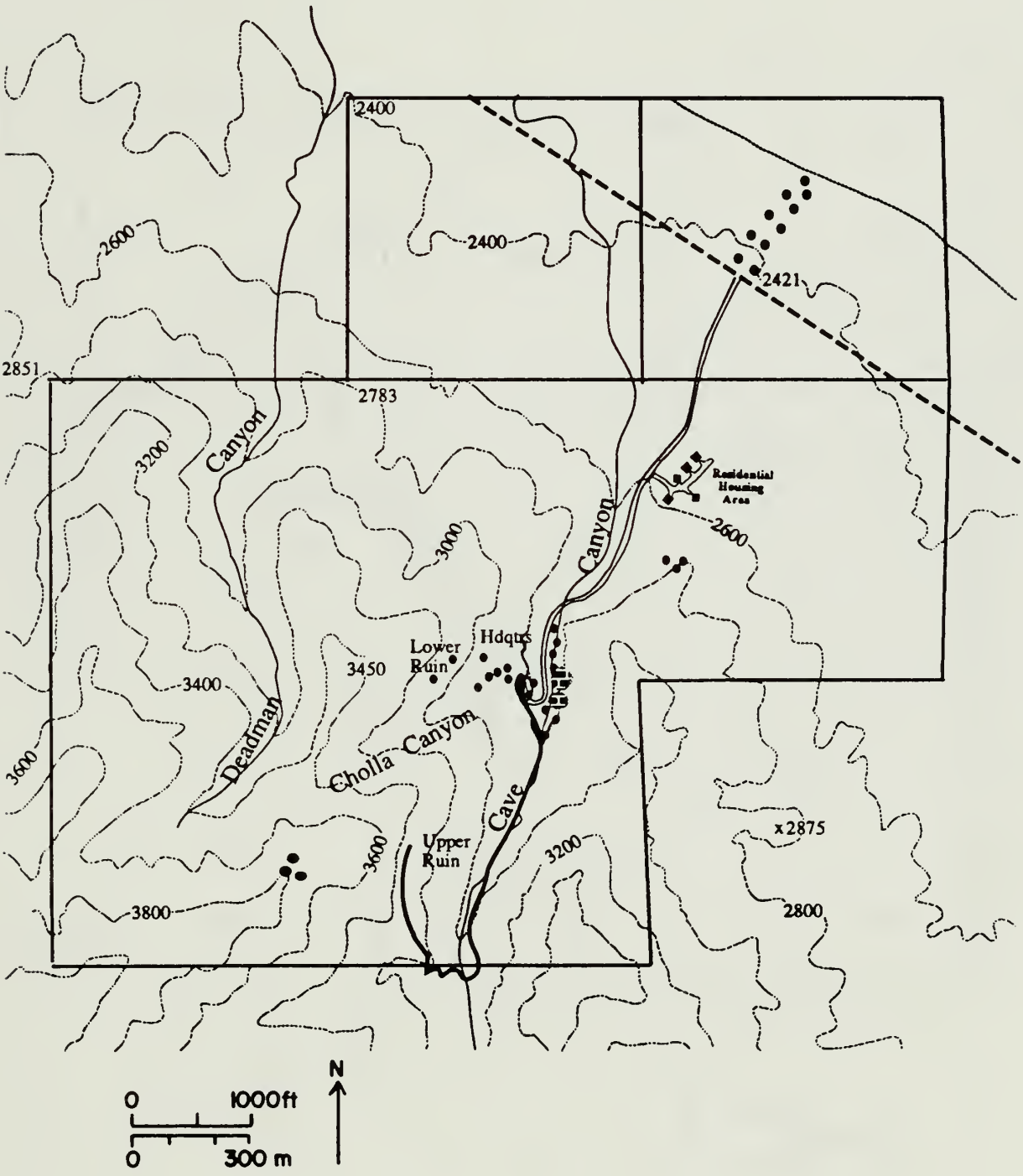
APPENDIX 5

LOCATIONS OF BOER LOVEGRASS (*ERAGROSTIS CHLOROMELAS*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



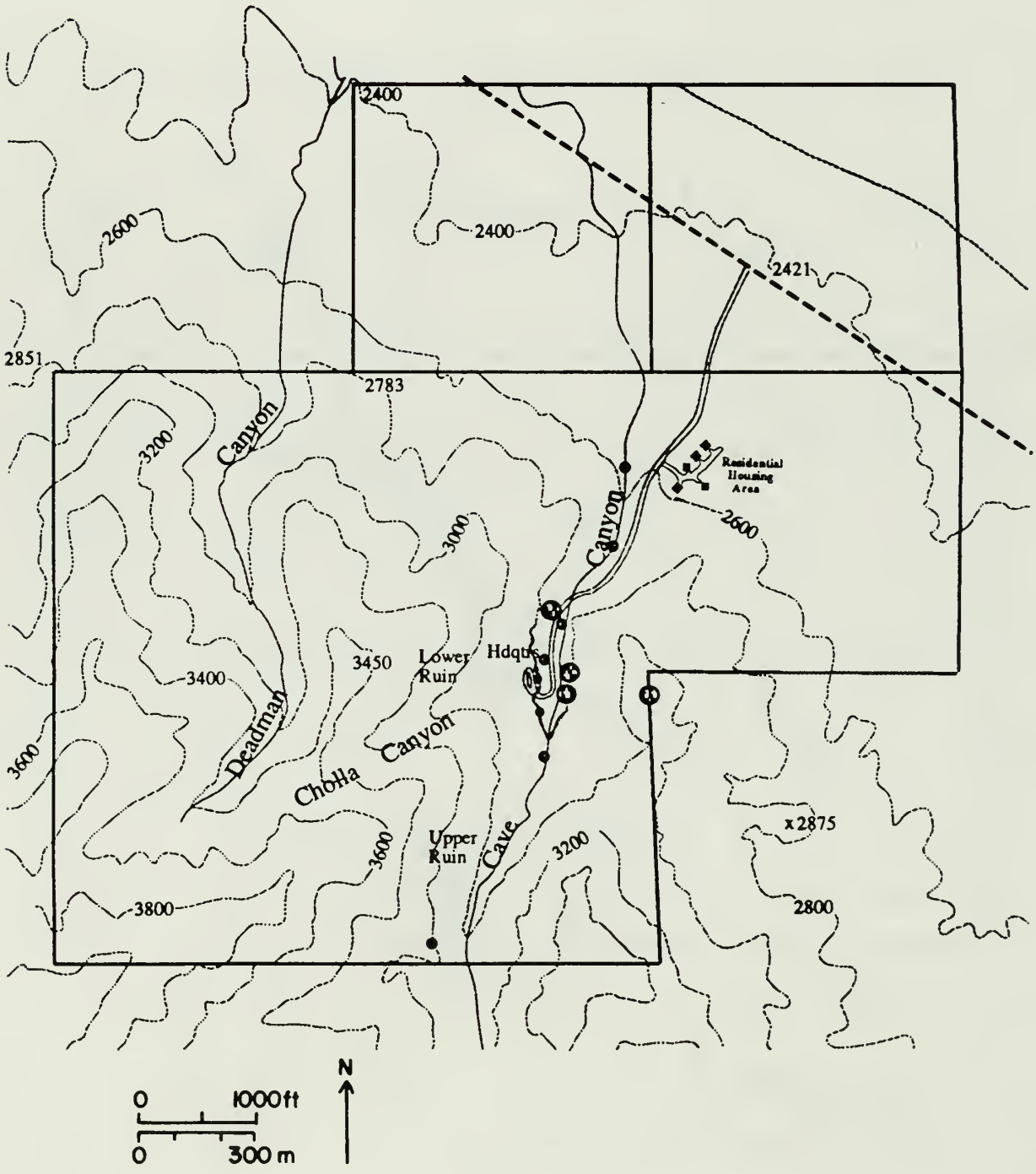
APPENDIX 6

LOCATIONS OF FILAREE (*ERODIUM CICUTARIUM*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



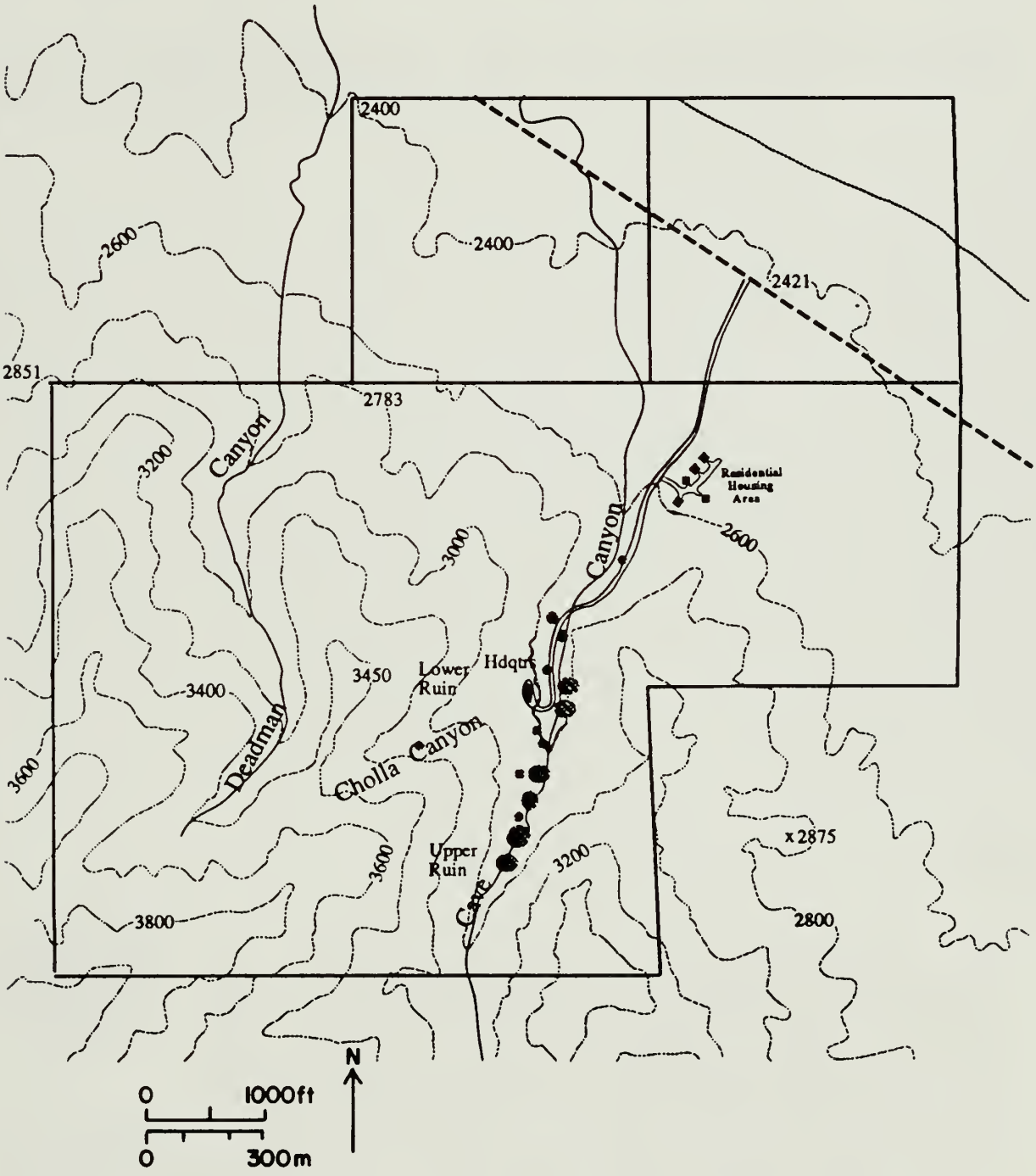
APPENDIX 7

LOCATIONS OF WILD BARLEY (*HORDEUM LEPORINUM*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



APPENDIX 8

LOCATIONS OF COMMON HOREHOUND (*MARRUBIUM VULGARE*) AT TONTO NATIONAL MONUMENT, ARIZONA, 1988



The cover photograph was taken October 4, 1935, in Saguaro National Monument by the first National Park Service photographer, George Alexander Grant (1891-1964).

As the nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting fish, wildlife and plants, preserving the environmental and cultural values of national parks and historic places, and providing for enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-9 August 1992